

Adapting to an Uncertain Water Future in California

David Groves, PhD

Evan Bloom, MA

RAND Corporation



California Water Plan to Evaluate Uncertain Future Water Management Challenges and Solutions

- How might water management conditions change between now and 2050?
- Which uncertain drivers are the most important?
- How can different water management strategies and response packages improve outcomes?
- What are the key tradeoffs among different strategies?



CWP Has Been Developing Data and Tools to Assess Future Water Management Conditions (I)

💧 Future Scenario Estimates

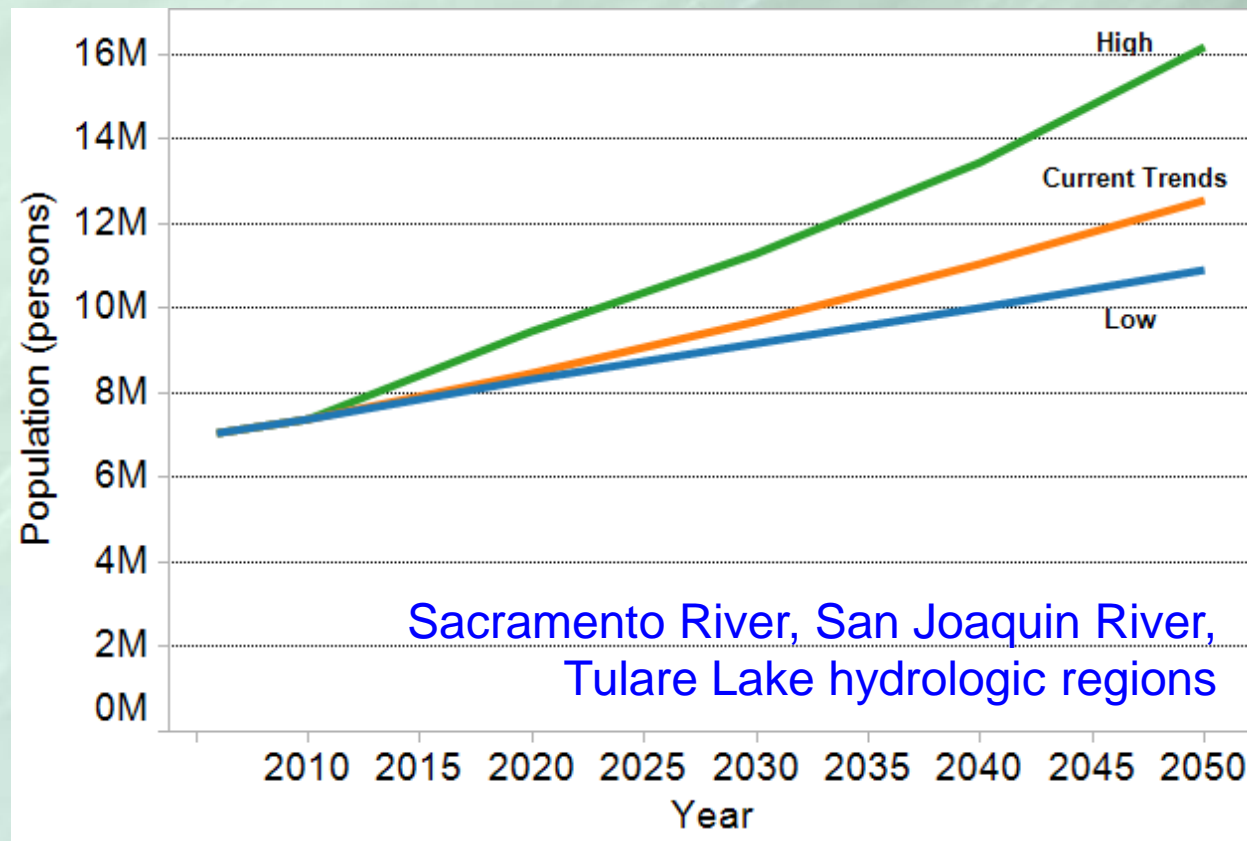
- Demographic changes
 - Population
 - Households
 - Economic activity
 - Agricultural irrigation requirements
- Climatic conditions
 - Temperature
 - Precipitation



Scenarios Reflect Changes in...

How Many People Live in California

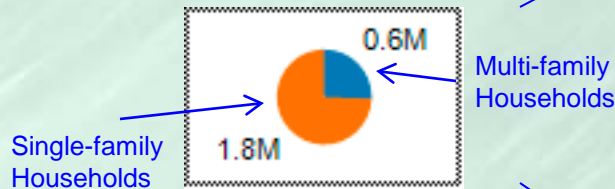
- 💧 Three population projections by hydrologic region



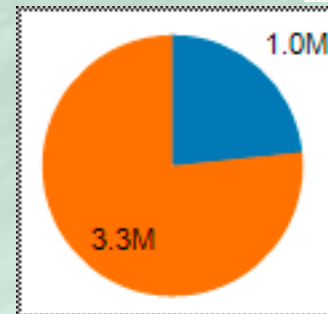
Scenarios Reflect Changes in... *Where and How People Live*

💧 Nine demographic scenarios:

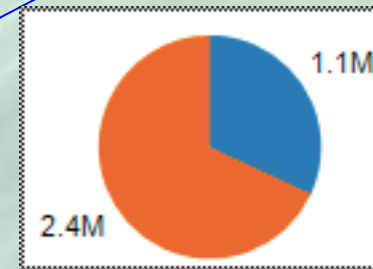
- Population (3)
- Urban density (3)



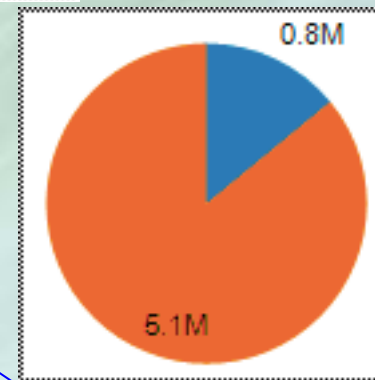
2006



Current trends
population and
density



Low population and
High density



High population
and low density

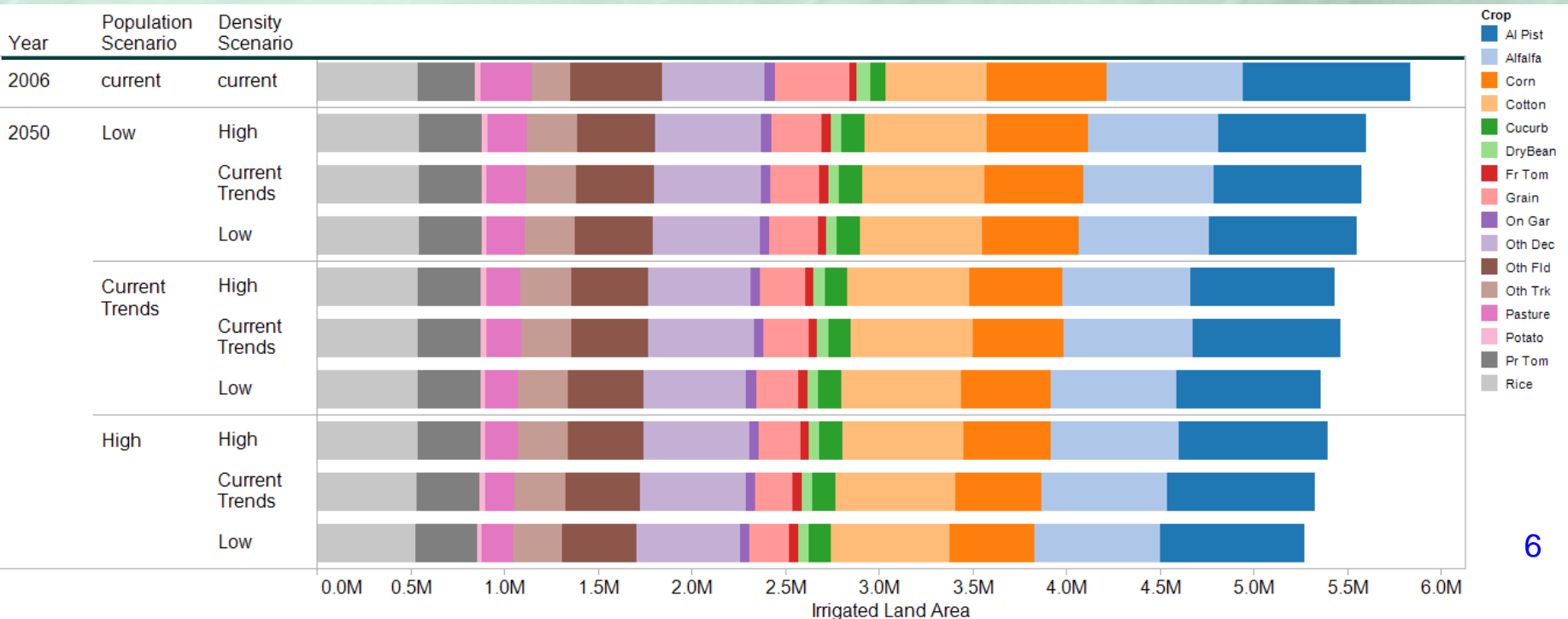
Six
Others



Scenarios Reflect Changes in...

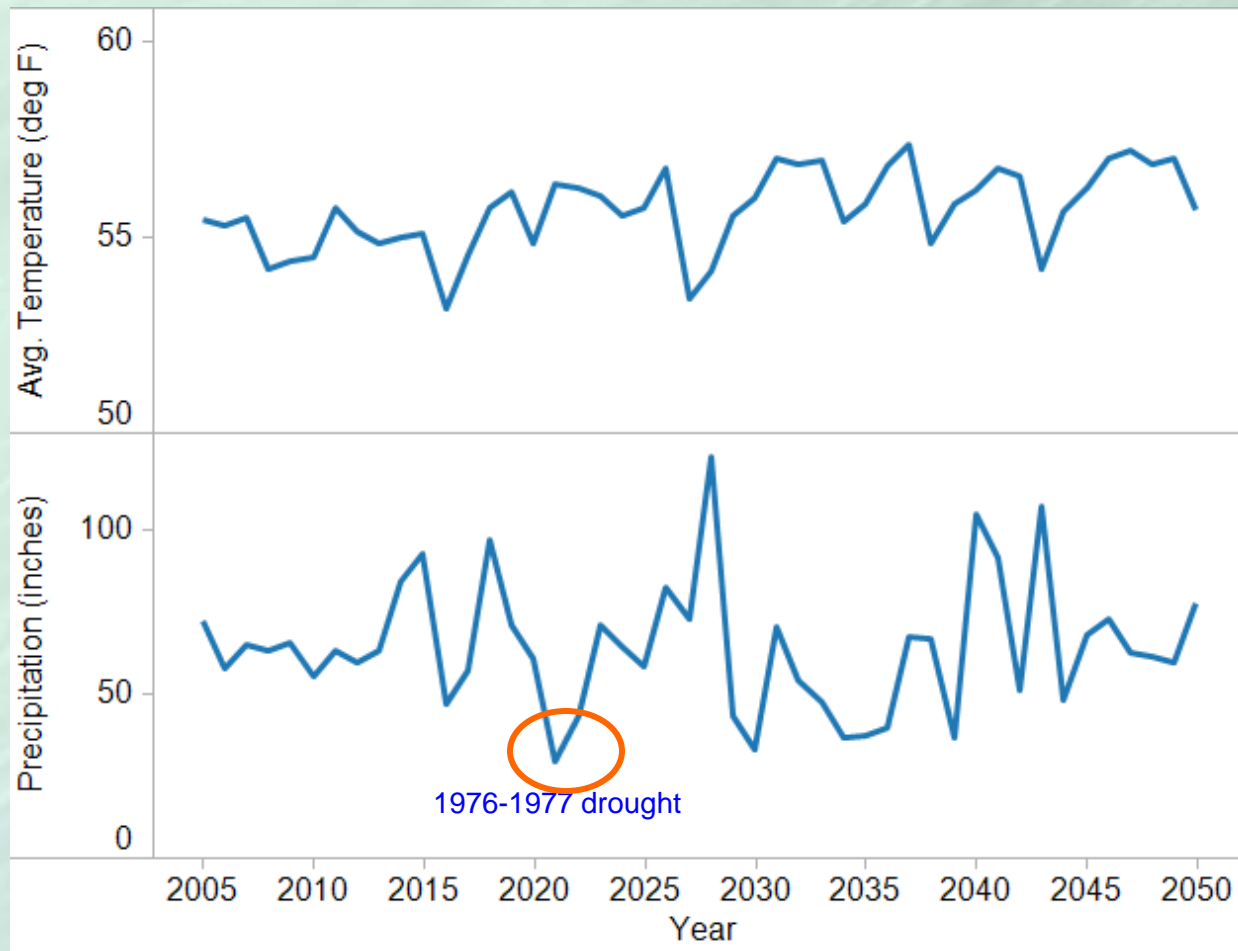
How Much Agricultural Land is Irrigated

- 💧 Nine scenarios of agricultural irrigation
 - Reflecting uncertainty about future urban development footprint



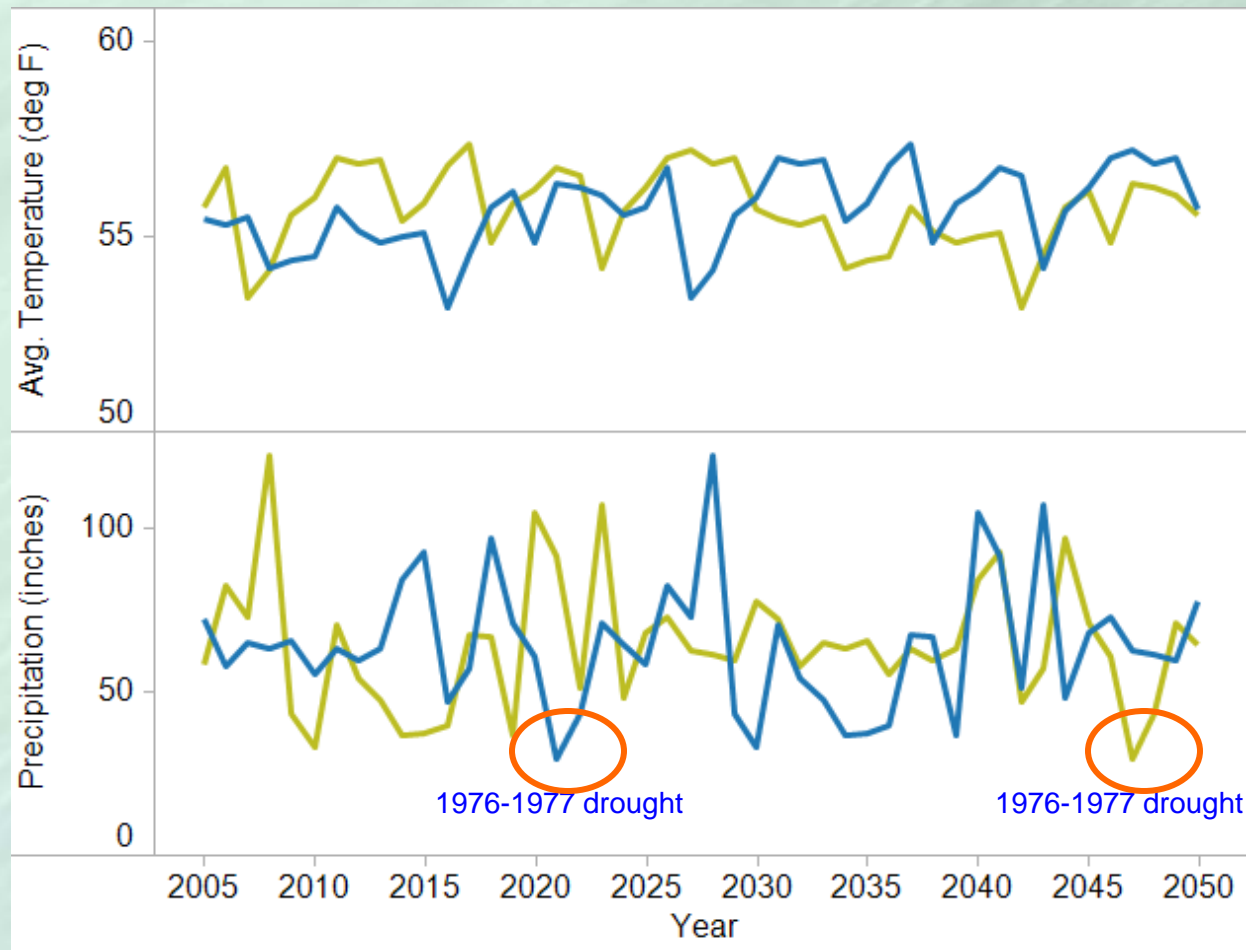
Scenarios Also Reflect Uncertainty about Future Climate

💧 Repeat of historical climate patterns



Scenarios Also Reflect Uncertainty about Future Climate

💧 Repeat of historical climate patterns

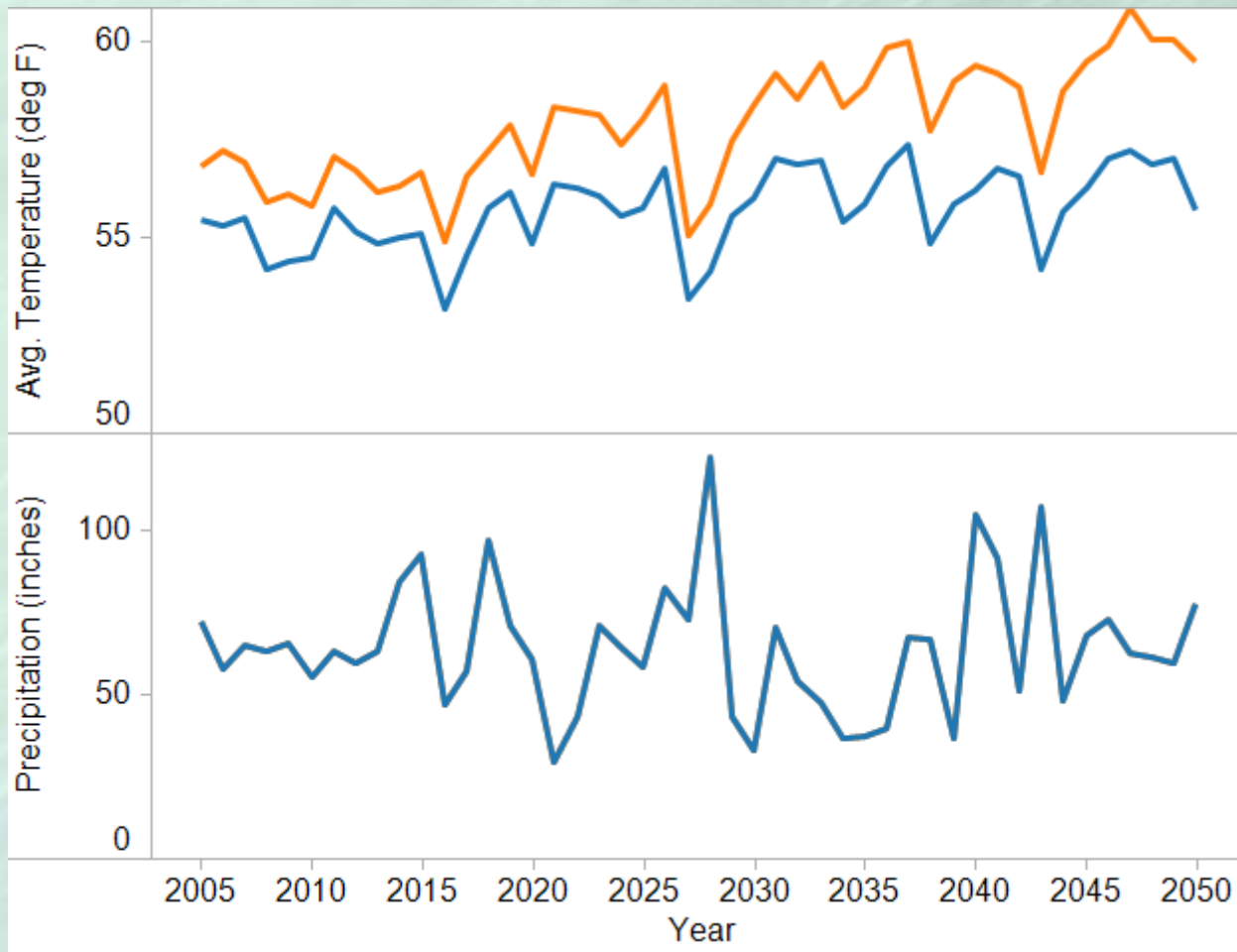


5 offsets
evaluated



Scenarios Also Reflect Uncertainty about Future Climate

- Repeat of historical climate patterns with climate warming

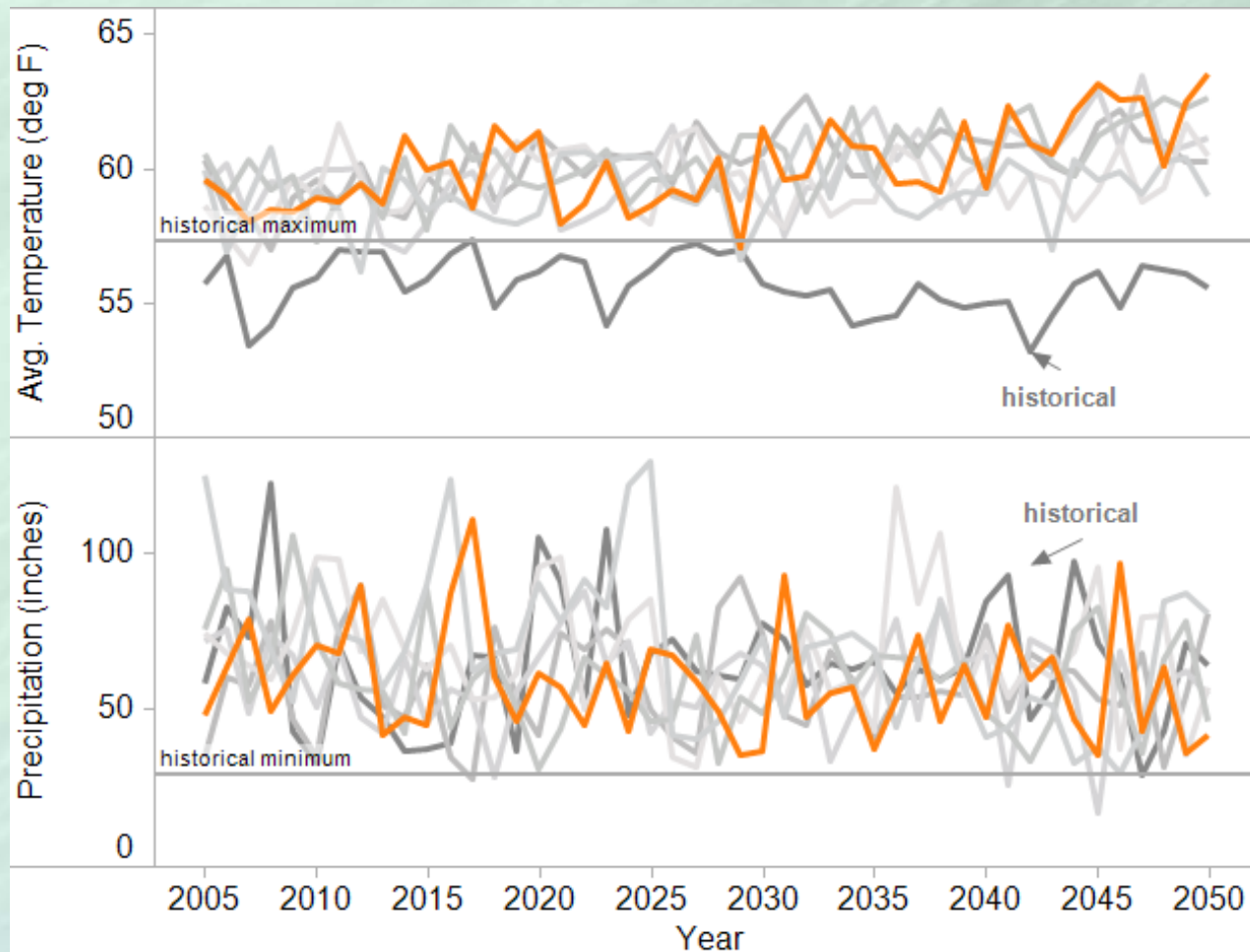


Average
Warming by
12 climate
models



Scenarios Also Reflect Uncertainty about Future Climate

- Global climate model scenarios of temperature and precipitation

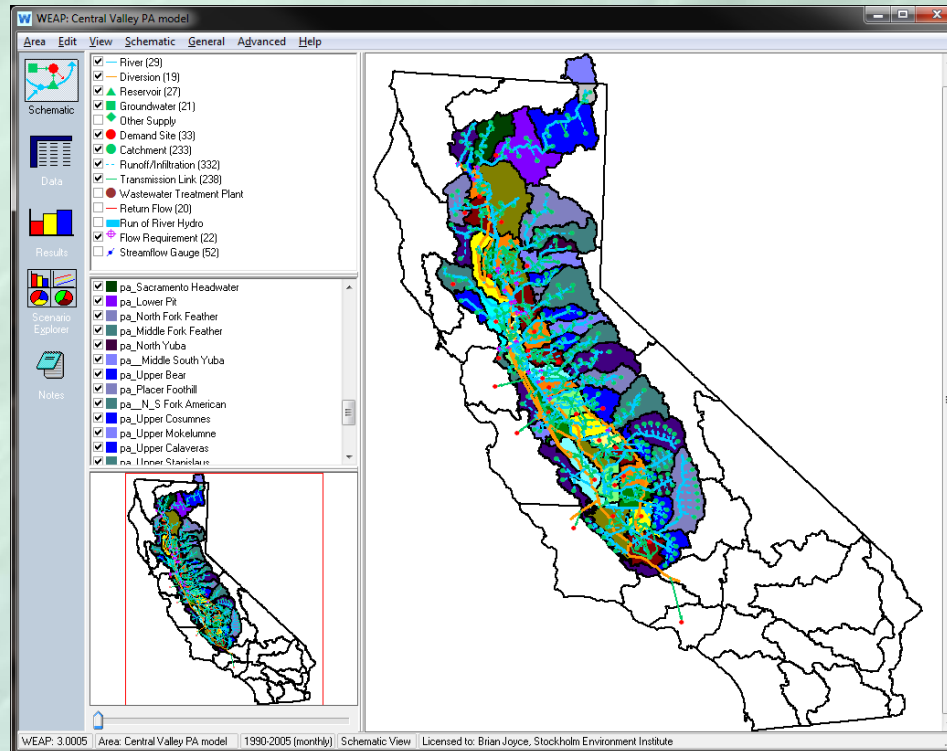


Showing
projections
from 6 of 12
climate
simulations



CWP Has Been Developing Data and Tools to Assess Future Water Management Conditions (II)









💧 Integrated Water Resources Management Model

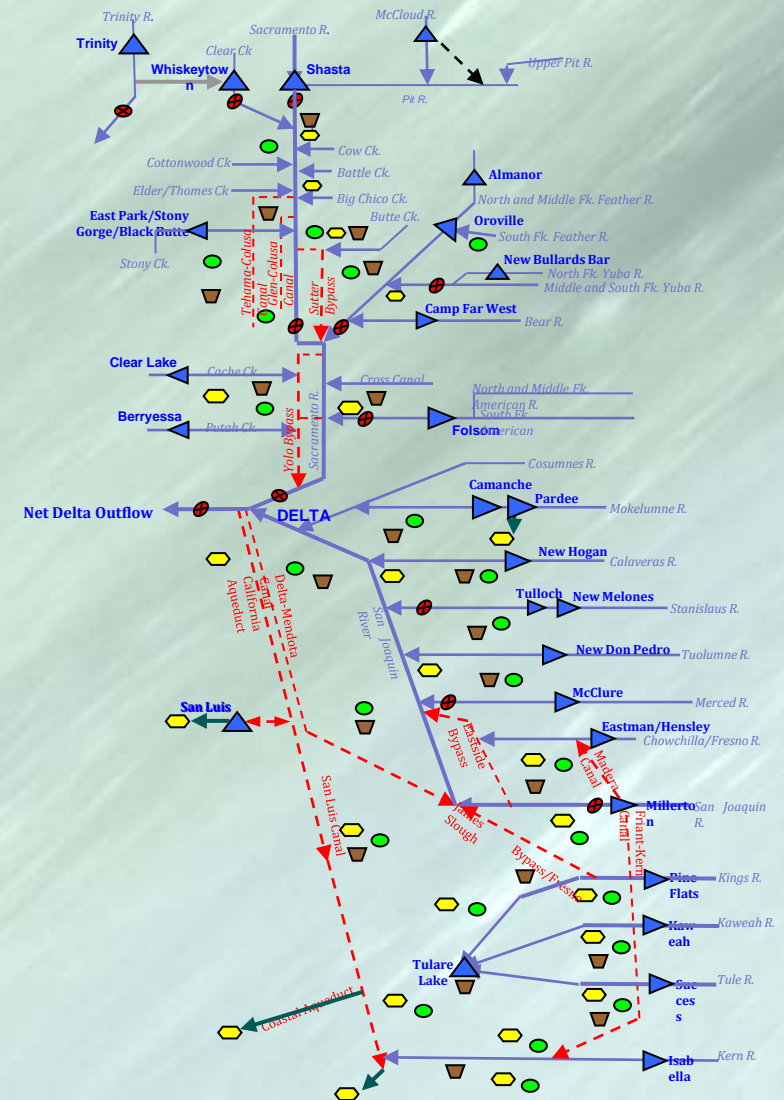


Water Evaluation And Planning (WEAP)
Central Valley Model



Central Valley Model Evaluates How the Water Management System Performs Under Different Scenarios

-  Interactive Groundwater
-  Irrigated Agriculture
-  Rivers and Tributaries
-  Inter-Basin Transfer
-  Canals and Diversions
-  Reservoir
-  M&I/Environ. Demand
-  Instream Flow Requirement



Water Evaluation
And Planning (WEAP)

Update 2013
California Water



Central Valley Model Estimates Wide Range of System Conditions

💧 What's included:

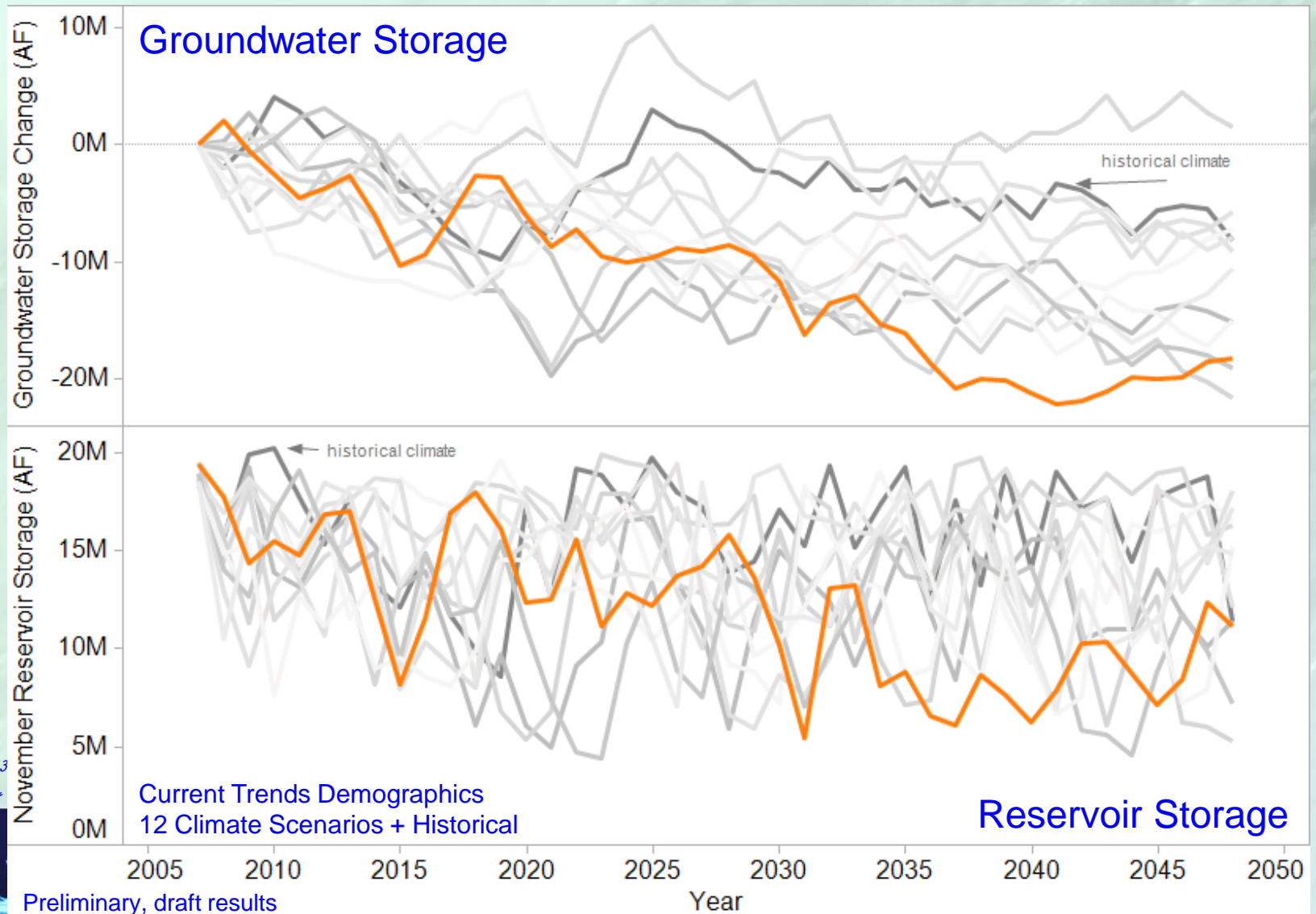
- Climate-driven hydrology: supply and demand
- Water supply operations
- Ecosystems: in-stream flow, managed wetlands
- Groundwater
- Water quality: Delta Salinity
- Monthly Bypass Flows

💧 What's NOT included, but could be:

- Economics
- Hydropower
- Water quality: Temperature, BOD



Example Outcomes: *Groundwater and Reservoir Storage*



Outcomes Summarized by Few Key Metrics



💧 Urban water supply reliability

- % of years in which most demand is met



💧 Agricultural water supply reliability

- % of years in which most demand is met



💧 Environmental performance

- % of months in which all In-stream Flow Requirements (IFRs) are met



💧 Cost of implementing strategies

CWP Has Been Developing Data and Tools to Assess Future Water Management Conditions (III)

💧 Interactive Results Visualization Tool



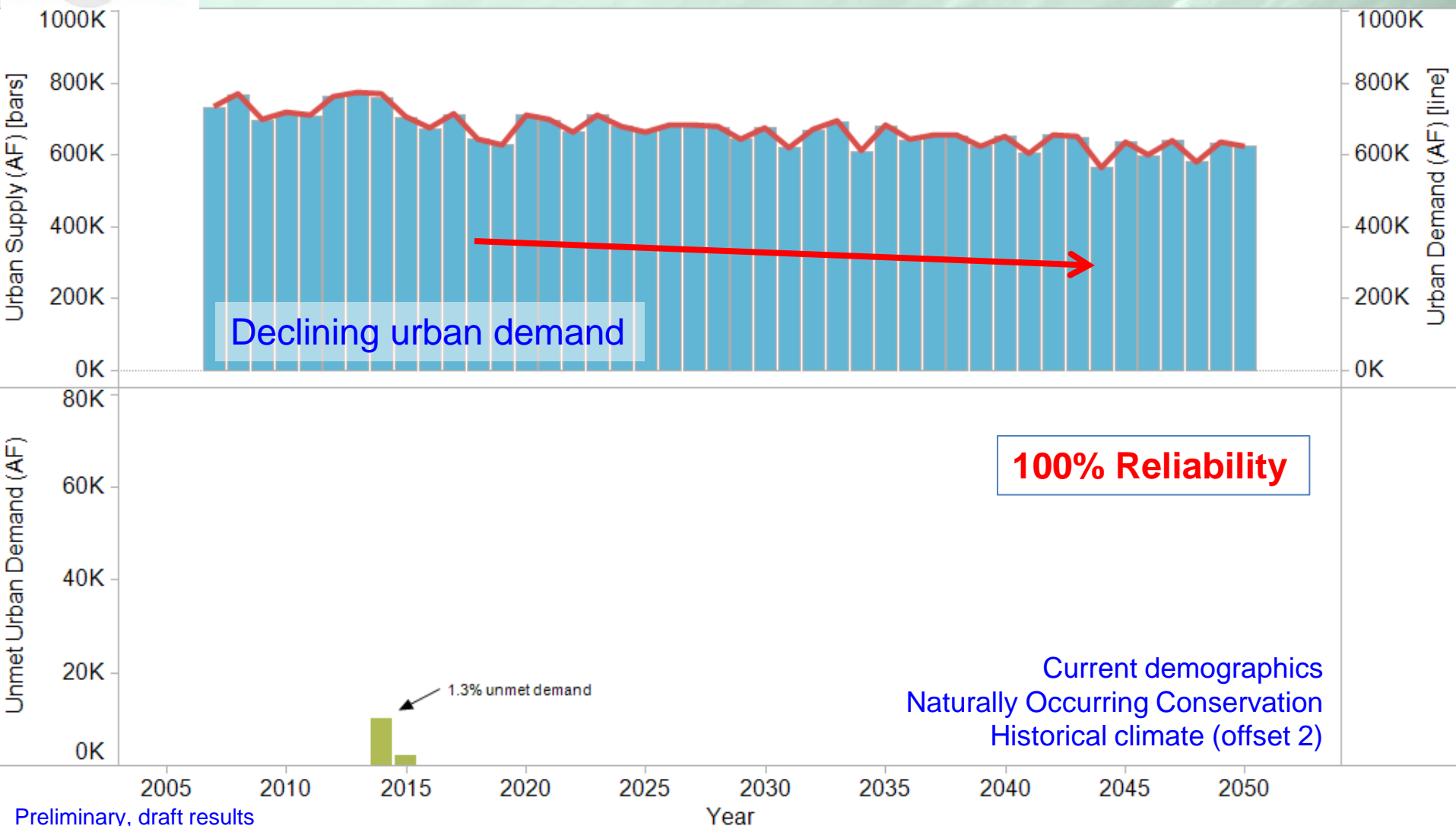
Developed using Tableau Software



How Does the Water System Perform Now in the Central Valley?



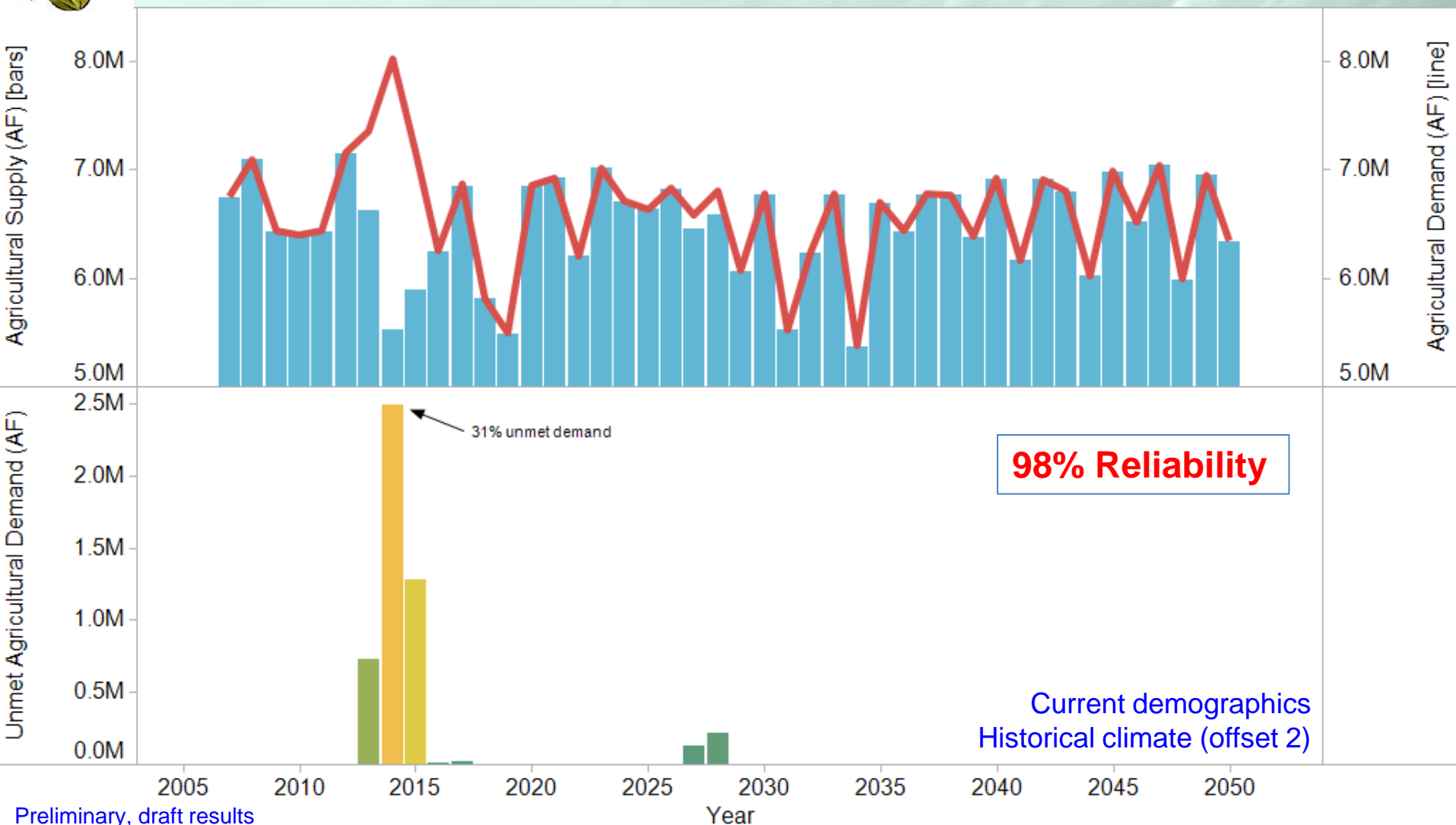
Urban Sector – Sacramento River Hydrologic Region



How Does the Water System Perform Now in the Central Valley?



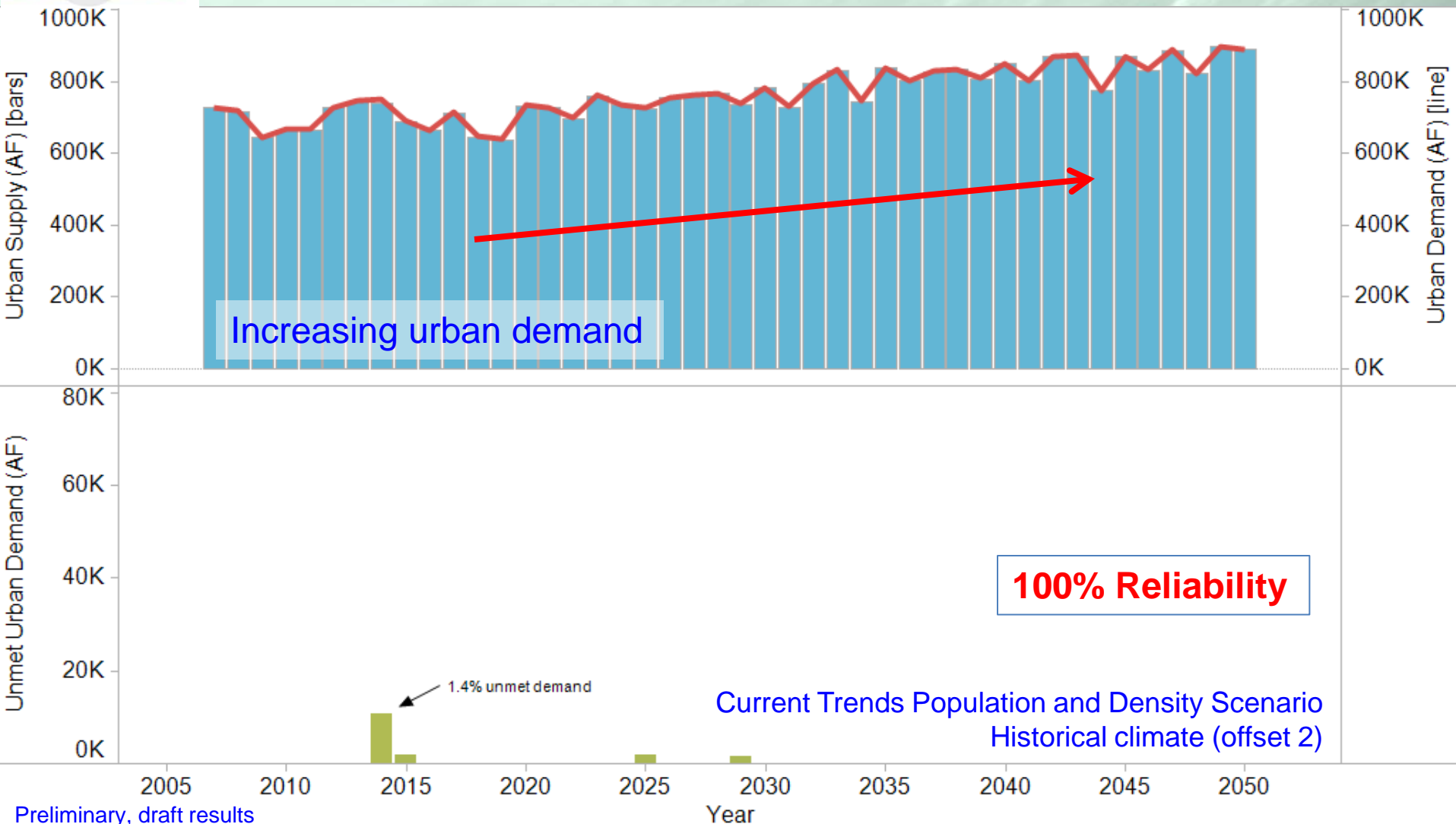
Agricultural Sector – Sacramento River Hydrologic Region



How Could Demographic Trends Affect the System in the Future?



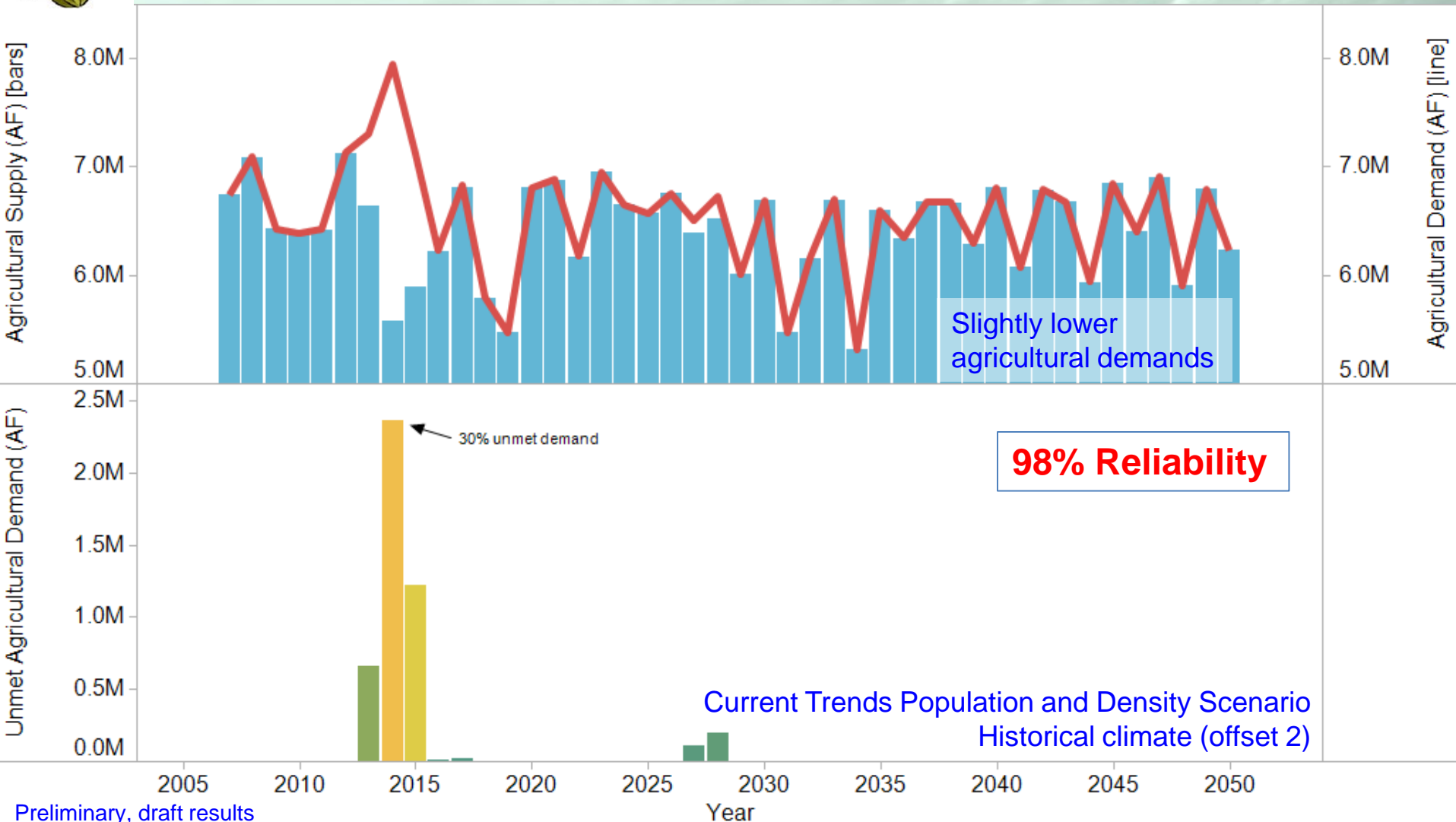
Urban Sector – Sacramento River Hydrologic Region



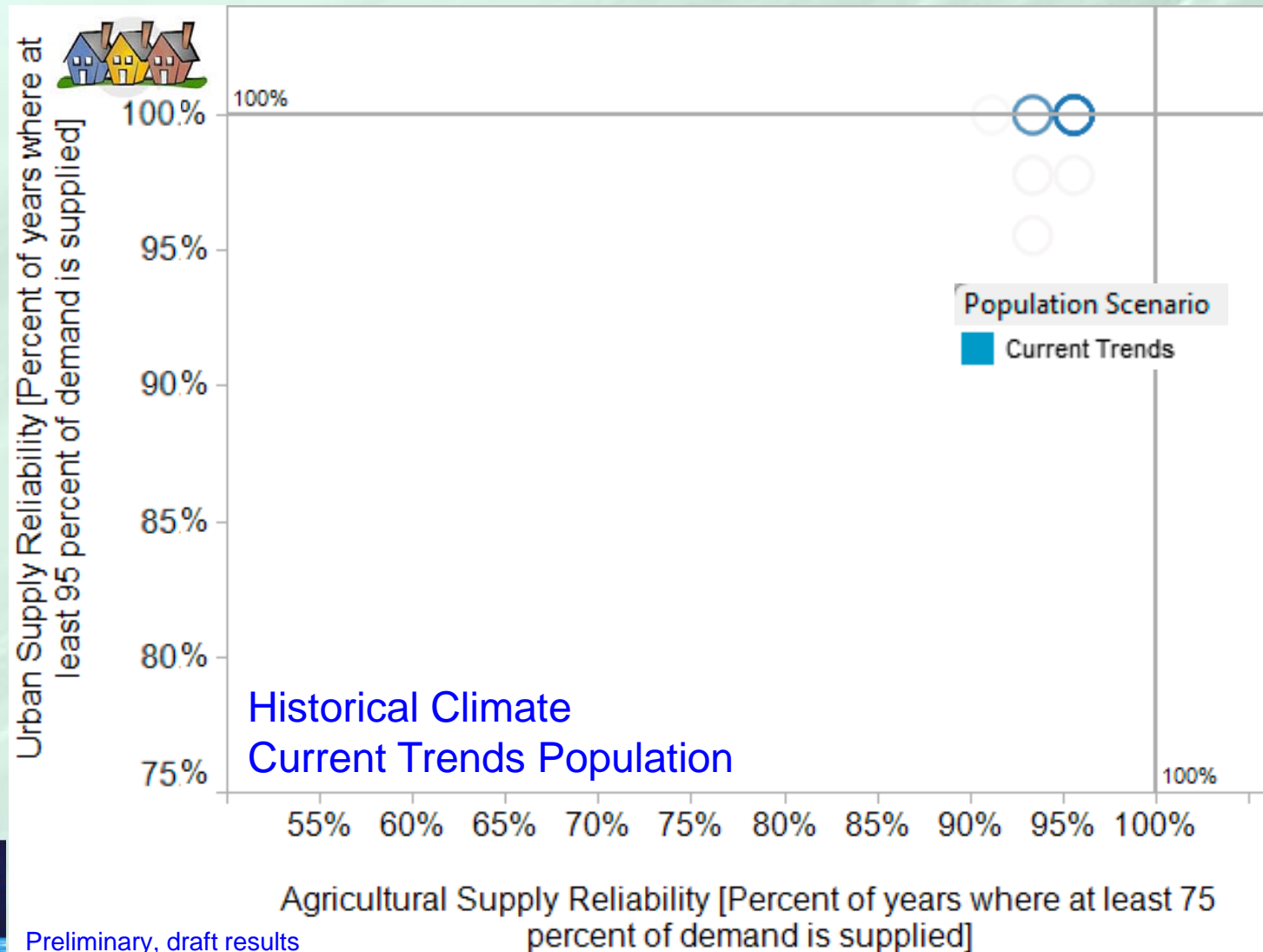
How Could Demographic Trends Affect the System in the Future?



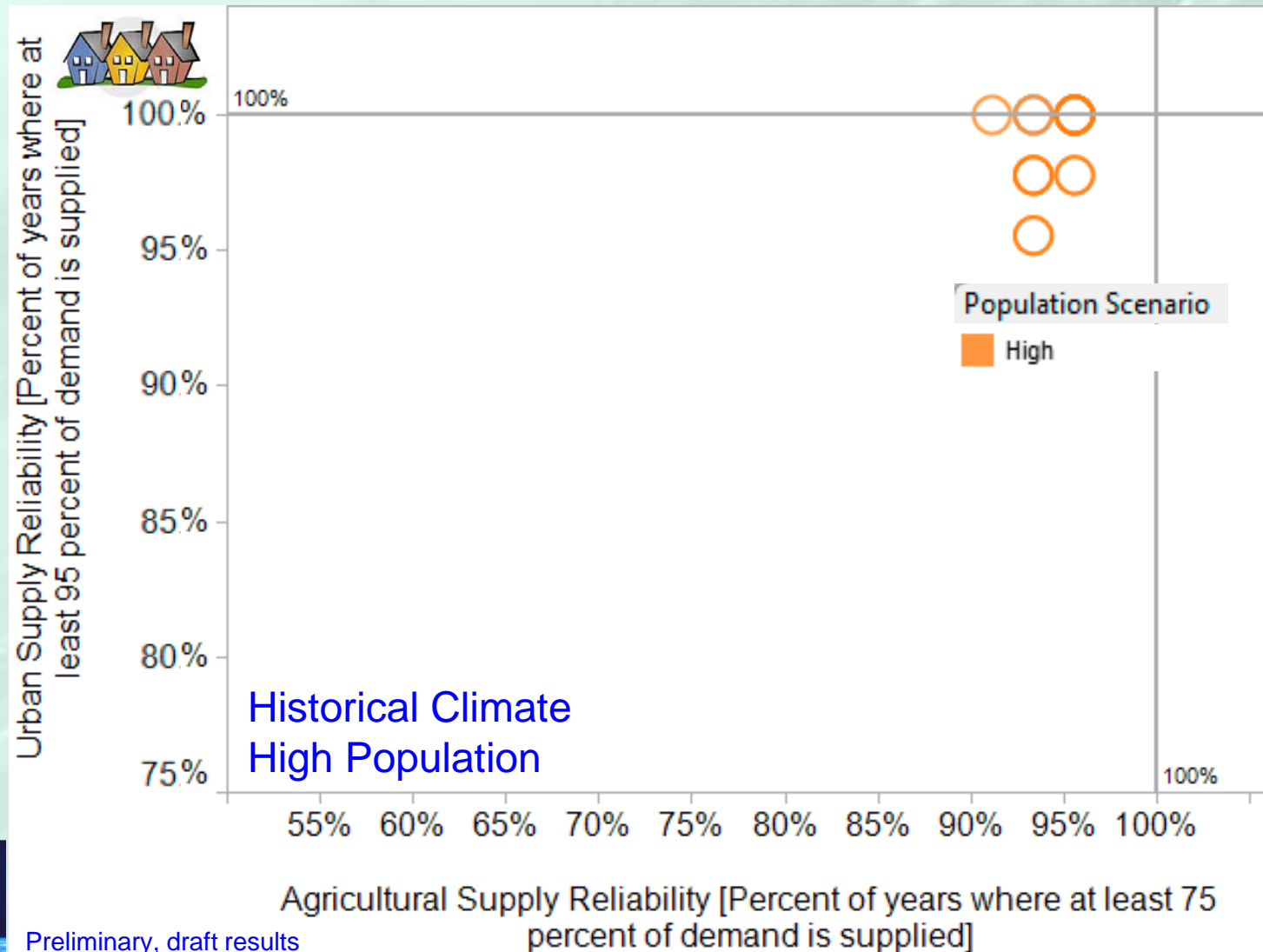
Agricultural Sector – Sacramento River Hydrologic Region



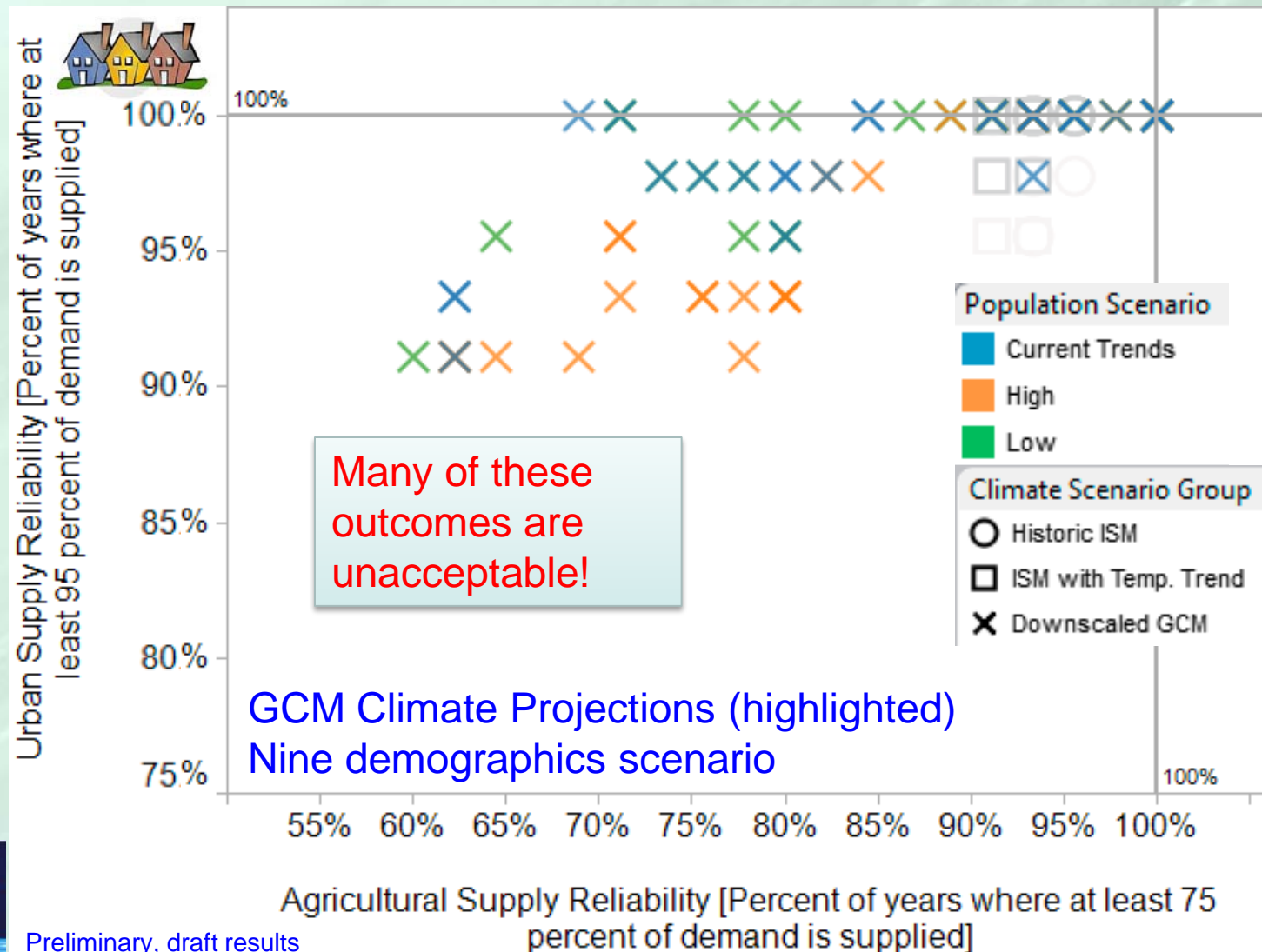
What About Different Plausible Climatic Conditions?



What About Different Plausible Climatic Conditions?

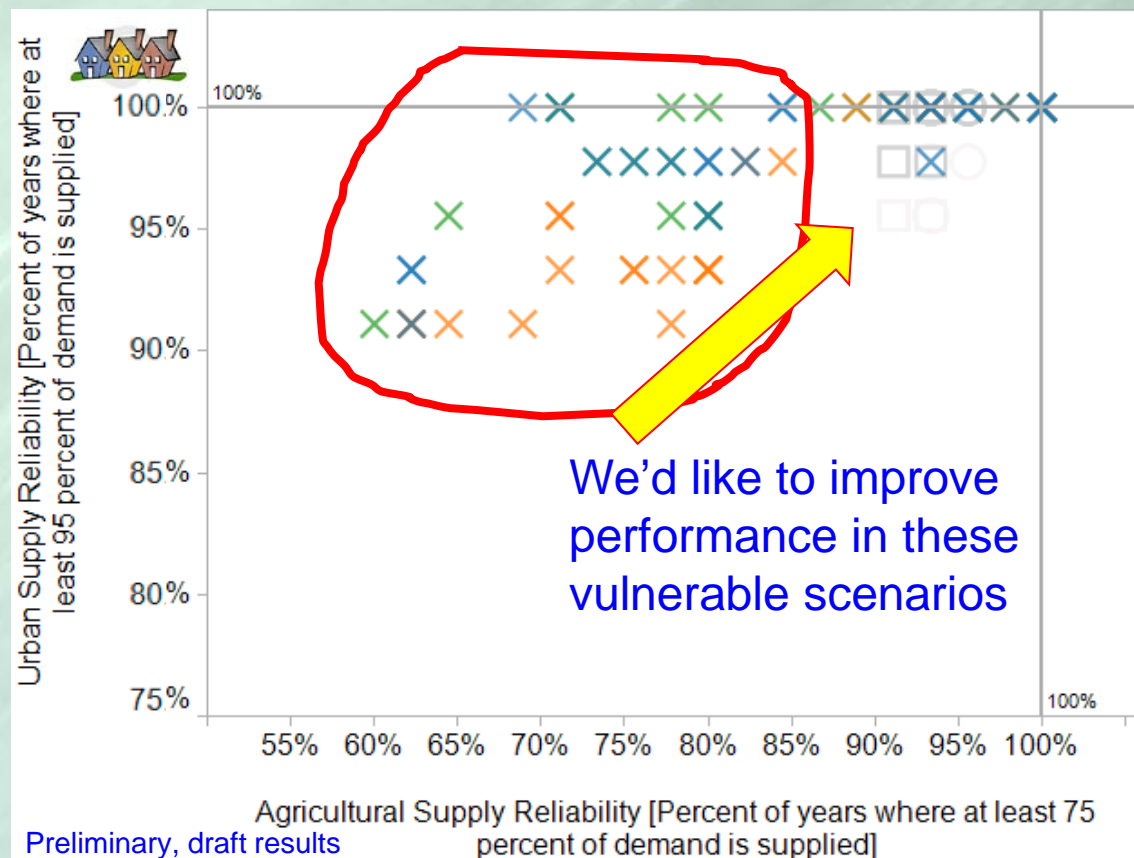


What About Different Plausible Climatic Conditions?



How Should We Prepare, Given the Uncertainty?

- Implement new water management strategies to reduce vulnerabilities



Water Management Strategies Can Reduce Vulnerabilities

- 💧 Urban and agricultural water use efficiency
- 💧 Reuse and conjunctive management
- 💧 Additional environmental flows and groundwater recovery
- 💧 New surface storage



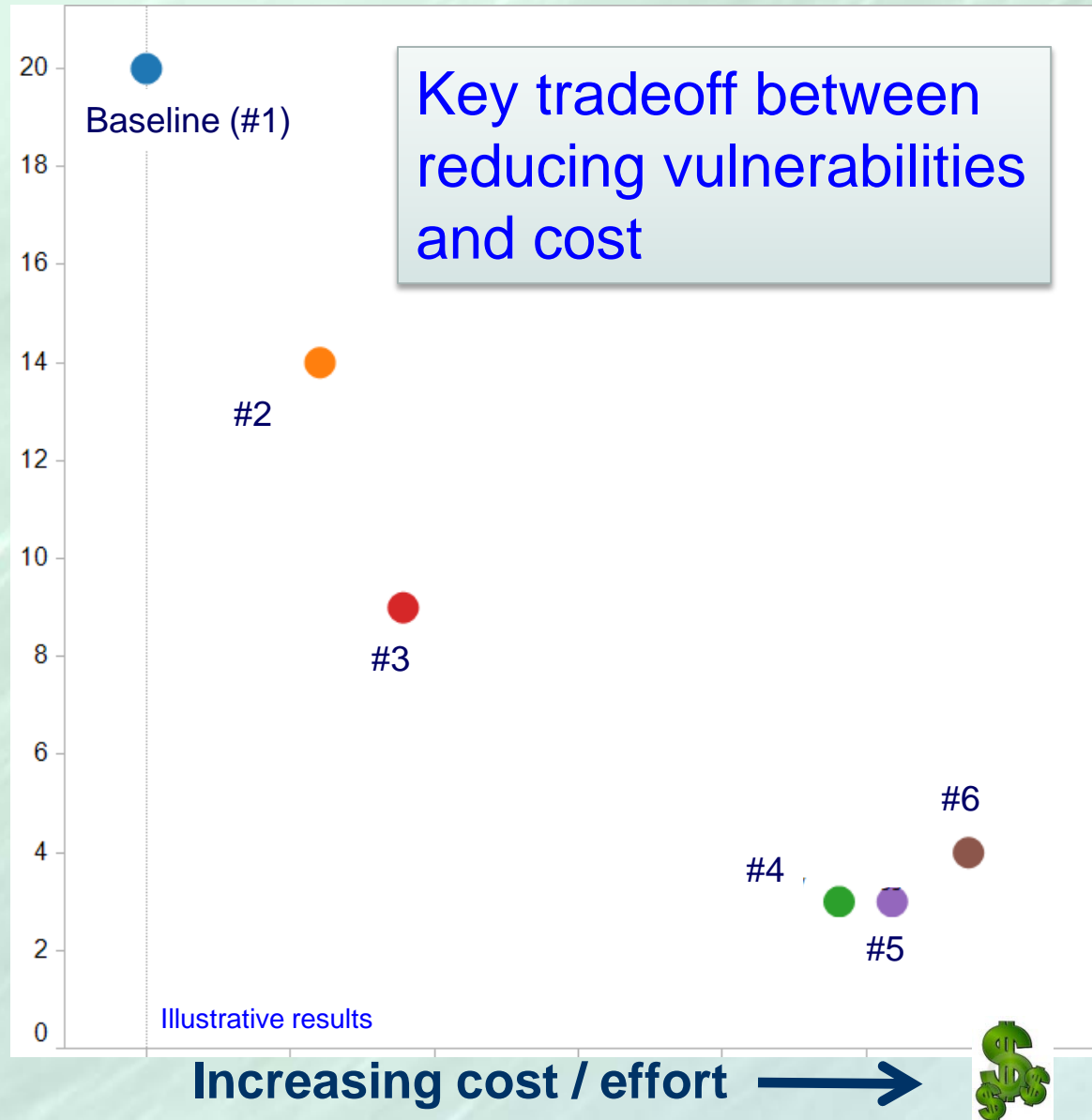
Response Packages Address Vulnerabilities in Different Ways

Water Management Response Package	Water use efficiency	Reuse and conjunctive management	Additional Environmental flows and groundwater recovery	New surface storage
Currently planned	currently planned	current	current	none
Diversification Level 1	moderate	moderate	currently planned	none
Diversification Level 2	aggressive	moderate	moderate	none
Diversification Level 3	aggressive	aggressive	moderate	one facility
Diversification Level 4	aggressive	aggressive	aggressive	two facilities



Implementing Response Packages Will Reduce Future Vulnerabilities

Better performance
(decreasing number of scenarios in which performance is unsatisfactory)



Update 2013
California Water Plan



Modeling and Analysis Status

- 💧 Finalize WEAP model
- 💧 Evaluate Current Management
- 💧 Characterize Vulnerabilities
- 💧 Evaluate Response Packages
- 💧 Describe Tradeoffs

Please attend up-coming SWAN workshop on analysis and results

